Original Article

Waiting Time of Inpatients before Elective Surgical Procedures at a State Government Teaching Hospital in India

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Abstract

Background: Abundant published literature exists addressing the issues of outpatient waiting lists before surgery. However, there is no published literature on inpatient waiting time before elective surgical procedures. **Objectives:** This study aims to measure the inpatient waiting time, identify the factors that affect the inpatient waiting time, and recommend the ways of reducing the waiting time of inpatients before elective surgical procedures, at a state government teaching hospital in India. **Methods:** Descriptive research methods and quality control tools were used for this prospective observational study. Descriptive statistics, Shapiro–Wilk test of normality, Wilcoxon-Mann–Whitney Test, and Kruskal–Wallis test were used. Pareto charts were used to highlight the most important modifiable factors among the set of factors causing increased waiting time. We also applied the M/M/c model (Erlang – A model) of queue theory to analyze the traffic intensity and system congestion. **Results:** The median waiting time of inpatients before elective surgery was 12 days (interquartile range = 11.5 days). The waiting time was influenced significantly ($P < 0.05$) by the patient's age, physical status, and the financial status. The surgical specialty, blood product booking and procurement, cross-specialty consultation before surgery, and Intensive Care Unit booking were the other important factors. **Conclusion:** Modifiable and nonmodifiable factors affecting the inpatient waiting time of surgical patients were identified. Control measures that can reduce the waiting time of inpatients before elective surgery were identified.

Key words: Elective surgical procedures, inpatients, waiting list

Introduction

Elective surgery is defined as when surgery is necessary, but the timing of the procedure can be scheduled, and the patient can be sent home.[1] Waiting time of patients before elective surgery is an important quality indicator of health-care services. Abundant published literature exists addressing the issues of outpatient waiting time before elective surgery. However, there is no published literature till date which addressed the inpatient waiting time before elective surgical procedures. Increased waiting time of inpatients directly increases the length of stay (LOS) in hospital. Increased LOS in hospital increases the chance of healthcare-associated infections[2] and also results in increased health expenditure. Waiting time before elective surgery greatly influences the satisfaction of the patients and their family members.[3]

This study was intended to measure the average waiting time of inpatients before elective surgical procedures, identify the most important modifiable influencing factors affecting the waiting time, and recommend the most effective ways of reducing the waiting time.

Materials and Methods

This prospective observational study was conducted at Kolkata Medical College and Hospital, West Bengal after approval from the Head of the Institution. Ethical committee review was exempted by the scientific committee since this study did not involve human participants.

We used the various quality control tools[4] in addition to the descriptive research methods in this study. The following data were collected for one continuous calendar month (January – February 2015):

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a. Medical records of all the inpatients undergoing elective surgery on each day at a multispecialty operation theater (OT) complex were reviewed. The following data were collected for each patient from the medical file and OT register: unique Patient ID, age, sex, American Society of Anesthesiologists (ASA) physical status of patients,[5] financial status of the patient (above poverty line (APL)/below poverty line [BPL]), the date of hospital admission, the date of preanesthesia check-up (PAC), date of elective surgery, surgical speciality, routine laboratory investigations done (Yes/No), PAC done (Yes/No), OT scheduling done (Yes/No), blood product booking (Yes/No), Intensive Care Unit (ICU) booking (Yes/No), and cross-speciality consultation before surgery (Yes/No)
b. Data from OT registers, admission, and discharge registers of Wards and ICU were used to validate the data obtained from medical records of patients
c. The number of completed surgeries and the number of cancelled surgeries on each day
d. The daily attendance of the various categories of OT staff (surgeons, anesthetists, nurses, general duty attendants (GDAs), and housekeeping staff)
e. Transcript of "expert interviews" of surgeons and anesthetists working in the OT complex were used for qualitative analysis of the causes of delay in the process of elective surgery.

During the period of one continuous calendar month, data were collected for equal number (four) of each day of the week (i.e., equal number of Mondays, Tuesdays, Wednesdays, Thursdays, Fridays, and Saturdays), to eliminate selection bias. This study measured the waiting time of all those surgical inpatients who underwent elective surgeries during the study. All these patients' records were followed up prospectively till their discharge from the hospital. We also studied the data already existing in the medical records of all these patients since their admission. This was done to avoid any censored waiting time data of patients who got operated in the OT complex during the period of the study. However, patients who got admitted under the surgical units for nonoperative treatments, and those discharged without elective surgery, or underwent emergency surgery in emergency OT were not included in the study.

Definitions used in this study

Waiting time of inpatients before elective surgical procedures was defined as the interval between the date of hospital admission and the date of surgery. The admission to surgery interval equals admission to PAC interval plus PAC to surgery interval.

Number of cancelled surgeries per day was defined as the number of patients sent back to the ward/ICU without undergoing surgery despite being put on the day's elective surgery list.

BPL patient was defined as a patient holding a "BPL Card" or "BPL Ration Card" or enlisted under "Annapurna"/"Antyodaya Yojana" (Pavement Dwellers' Welfare Program), or those certified as BPL by a competent Government Authority. APL patient was defined as any other patient who does not fulfill the criteria of BPL as defined above.

The "utilized OT time" for each OT on a day was the time interval in hours, between the first-patient in-time to the last-patient out-time. The total utilized OT time of the OT complex on a day was calculated by adding the "utilized OT time" of each of the five studied OTs on that day.

The "available OT time" for each OT was calculated from the official working hours of the OT. The total available OT time on a day was calculated by adding the "available OT time" of each of the five studied OTs on that day.

"OT efficiency" was defined as the ratio of "utilized OT time" to the "available OT time" for each day.

The following quality control tools were used in this study

Electronic check sheets (OpenOffice Calc 4.1.1 spreadsheet) were used to collect data as they were generated at their source. Separate check sheets were used to capture data for every single day (date) of the study period containing data of all the patients operated on that day only. A single check sheet was used to capture data for daily OT utilization time during the study. Data from check sheets (primary data) were compiled to form a master spreadsheet (secondary data) before importing into SPSS version 13.0 (IBM Corp., Armonk, NY, USA) for further analysis. Pareto charts were used to highlight the most important modifiable factors among the set of factors causing increased waiting time. We also applied the M/M/c model (Erlang – A model)[6] of queue theory to analyze the traffic intensity and system congestion.

Majority of the continuous variables were found to be nonnormally distributed. Hence, all the continuous variables were expressed as median, range, and interquartile range (IQR) for central tendency and dispersion. Categorical data were expressed as count and percentages. Wilcoxon-Mann–Whitney Test and Kruskal–Wallis Test were used for finding any significant difference in waiting time intervals and LOS according to various independent categorical variables. $P<0.05$ was considered statistically significant for all statistical tests (considering alpha error to be 5%).

Results

Five OTs were functional on each day at the OT Complex during the study. The working hours of the OT complex were 0900–1600 h (7 h and each OT, total 35 h/day) from Monday to Friday; 0900–1400 h (5 h each OT, total 25 h/day) on Saturday. The OT Complex remained closed on public holidays.

The demographic composition of the surgical inpatients during the study was 67.12% male (54.79%, 10.96%, 1.37% with ASA physical Status I, II, and III, respectively) and 32.88% females (21.92%, 10.05%, 0.92% with ASA physical Status I, II, and III, respectively). The number (proportion) of BPL

and APL patients who underwent surgery during the study was 80 (36.5%) and 139 (63.5%), respectively. The median age of the patients was 35 years (range 3–86 years, IQR 27 years).

A total of 219 surgeries were completed during the study. The median waiting time of inpatients before elective surgery was 12 days (range 2–119 days, IQR 11.5 days). The waiting time and LOS of patients in various surgical specialties are described in Table 1.

The waiting time of inpatients before elective surgery was influenced significantly by several nonmodifiable factors including the ASA physical status of the patient, and the financial status of the patient, but independent of the sex of the patient [Table 2]. The average waiting time of BPL inpatients before surgery (Median 21 days, IQR 19.4 days) was more than triple than that of APL inpatients (Median 6 days, IQR 6.5 days). This waiting time is skewed in the disfavor of BPL inpatients, in spite of universal health coverage in place. BPL patients' surgeries were often delayed, apparently due to delay in preoperative laboratory tests, arranging and procuring medicine, consumables, and blood products (as per data from expert interviews). The average waiting time of ASA physical Status III (Median 13 days, IQR 6 days) and ASA physical status II patients (13 days, IQR 9.8 days) was more than that of ASA physical status I patients (Median 10 days, IQR 12 days). Patients requiring blood booking waited more (Median 14 days, IQR 13 days) than those not requiring blood (Median 10 days, IQR 11 days). Patients with cross-specialty referral waited more (Median 16 days, IQR 16.8 days) than those not referred (Median 10 days, IQR 11 days). Patients requiring ICU waited more (Median 13 days, IQR 5 days) than those not requiring ICU (Median 12 days, IQR 12 days).

The OT utilization and efficiency metrics were satisfactory [Figure 1]. The median number of surgeries completed daily and that cancelled daily were respectively 9 (range 6–12, IQR 3.3), and 0 (range 0–3, IQR 1). The median number of utilized total OT time per day was 26.71 h (range 16–37 h, IQR 6.42 h), out of median number of available total OT time per day of 35 h (range 25–35 h, IQR 0). The median OT efficiency was 81.20% (range 56.43–106.43%, IQR 43.93%).

Pareto chart analysis shows the modifiable factors influencing the waiting time before surgery (in highest to lowest order of influence) as laboratory investigations, PAC, OT scheduling, blood product booking and procurement, cross-specialty consultation before surgery, and ICU booking [Figure 2].

The average number of patients admitted daily (patient arrival rate) for elective surgery to be done in our OT complex was 10/day. The average waiting time for surgery (average service time) was 12 days. The number of Operating Rooms (number of servers) were 5; the number of indoor beds for such waiting patients (size of the queue = K) were finite. By applying the M/M/c/K (Erlang–A) model[6] of queueing theory, we have

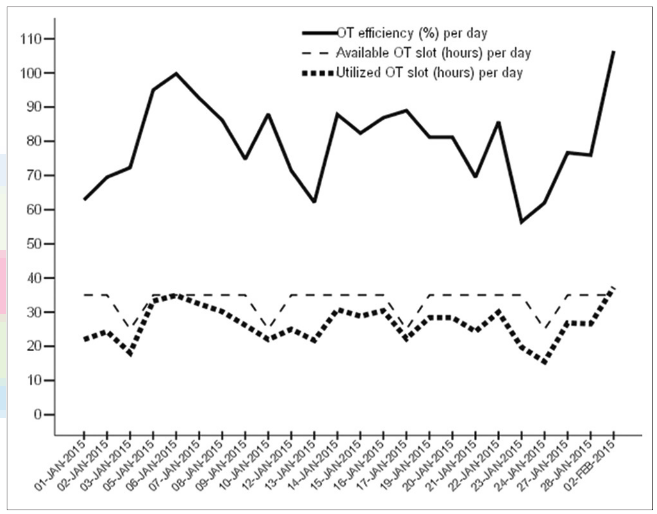

Figure 1: Line diagram of operation theater efficiency.

Table 1: Descriptive statistics of waiting time and length of stay according to surgical specialties

Dependent variables	Categorical variables						
	Overall (n=219)	General surgery (n=28)	Orthopedics (n=135)	Plastic surgery (n=32)	Surgical gastroenterology (n=7)	Surgical oncology (n=12)	Neurosurgery (n=5)
Admission to surgery interval (days)							
Median, (minimum-maximum)	12 (2-119)	5 (3-21)	13 (2-73)	16.5 (2-119)	16 (3-19)	9.5 (2-26)	8 (3-15)
IQR	11.5	7.7	14.4	28.4	9.2	10.9	10
Admission to PAC interval (days)							
Median, (minimum-maximum)	3 (0-112)	2.5 (0-18)	3 (1-70)	3.5 (0-112)	9 (1-16)	5.5 (0-24)	2 (2-13)
IQR	5.5	6.2	10.8	28.4	9.2	10	7.4
PAC to surgery interval (days)							
Median, (minimum-maximum)	5 (1-41)	3 (1-12)	6 (0-41)	9.5 (1-32)	3 (1-10)	4.5 (1-15)	2 (1-6)
IQR	9	3.6	10	12.3	5.1	6.4	4.2
Total LOS in hospital (days)							
Median, (minimum-maximum)	18 (5-125)	13 (6-31)	18 (5-78)	25 (9-125)	25 (14-31)	20 (9-34)	16 (8-27)
IQR	13	8.6	14.4	28.2	9.3	11.2	14.2

LOS: Length of stay, IQR: Interquartile range, PAC: Preanesthesia check-up

Table 2: Differences in the inpatient waiting time before surgery and total length of stay in hospital among independent grouping variables

Dependent variables	Independent grouping variables						
	Wilcoxon-Mann-Whitney U-test with continuity correction (comparing two groups of independent variables with non-parametric dependent variable)					Kruskal-Wallis test (comparing more than two groups of independent variables with non-parametric dependent variable)	
	Sex-male and female	Financial status of patient-APL and BPL	Blood booking-yes and no	ICU Admission-yes and no	Cross-specialty consultation-yes and no	ASA PS-I, II, and III	Surgical specialties-general surgery, orthopedics, plastic surgery, surgical gastro, surgical onco, and neurosurgery
Admission to surgery interval (inpatient waiting time before surgery)	0.98	<0.05*	<0.05*	0.95	<0.05*	0.02*	<0.05*
Total LOS in hospital	0.44	<0.05*	<0.05*	0.24	<0.05*	<0.05*	<0.05*

*$P<0.05$ was considered statistically significant. APL: Above poverty line, BPL: Below poverty line, ICU: Intensive Care Unit, ASA: American Society of Anesthesiologists, PS: Physical status, LOS: Length of stay

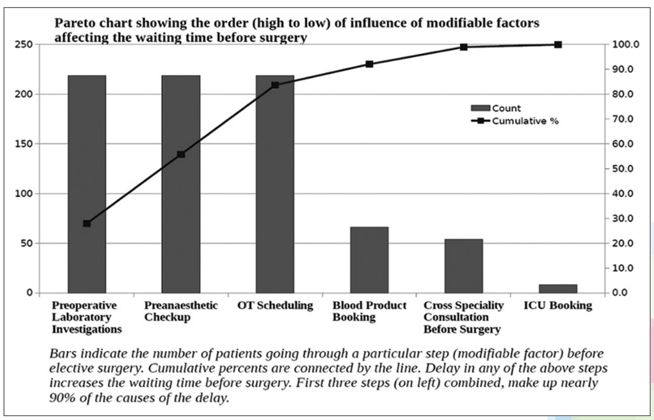

Figure 2: Pareto chart of modifiable factors affecting waiting time.

seen that: The "traffic intensity" of the system during the study was 24.0, indicating abnormally high congestion of the system. The system's traffic intensity = (patient arrival rate/[number of servers/average service time]), was measured using Erlang–A model[6] of queue theory. Observed service disciplines in our study were: First–In, First-Out (who comes earlier leaves earlier); and preemptive priority (clinician decides surgical priority).

Discussion

Large-scale study data exist for surgical waiting time – OECD countries,[7] NHS in the UK.[8] However, the waiting time defined in all these studies was the "outpatient waiting time," i.e., interval between the referral by the primary care physician to admission for surgery, or the interval between the first surgical consultation to the admission for surgery. We have studied "inpatient waiting time" in contrast to the well-studied "outpatient waiting time." Inpatient waiting time before surgery is an important problem in government teaching hospitals since inpatients keep the surgical beds occupied while waiting for surgery.

We studied five OTs which were located in a common complex in a particular building. These OTs comprise only a fraction of the total surgical services of this hospital spread over twenty-three OTs which are grouped heterogeneously and located in different buildings. These five OTs were chosen because they were physically part of a single OT complex, sharing common resources. The variety of surgery observed during the study period included common major surgical procedures such as cholecystectomy, hernia repair, modified radical mastectomy, arthroscopic surgery, open orthopedic procedures, total knee replacement, and minimally invasive orthopedic procedures. A large number of complex major surgery were also observed, like head-neck tumor excision with neck dissection and free-flap reconstruction, Whipples operation, liver resection, revision of total hip replacement, abdominoperineal resection, complex spine surgery, complex free-flap reconstructive surgeries, Frey's operation with Roux-en-Y hepaticojejunostomy, transthoracic oesophagectomy, radical nephrectomy, radical cystectomy with ileal conduit, D2 gastrectomy, etc.

The surgical and anesthesia consultants (Professor, Associate Professor, Assistant Professor and RMO-Clinical Tutors) are full-time consultants of the institute, available daily from 9 AM to 4 PM, except public holidays. Services rendered by Consultants beyond working hours are not compensated by additional remuneration. The trainee surgeons, trainee anesthetists, nursing staff, GDA, and housekeeping staff were available for these OTs between 8 AM and 8 PM every day, except public holidays. The laboratory services were available round the clock.

The government published data (2011–2012) on the proportion of BPL population in West Bengal was 19.94% (India, 21.92%).[9] Since poor patients usually seek low-cost healthcare services, is not surprising that 36.5% of the patients in our study were BPL, reflecting a higher proportion of BPL patients seeking low-cost healthcare in government hospital than APL patients.

This study has also shown the existence of significant inequalities in the waiting time between BPL and APL patients

despite the implementation of universal health coverage policy. There is lack of single point integration of preoperative laboratory investigation and imaging in this hospital. A patient has to make multiple visits to multiple laboratories on multiple days to complete preoperative workup, i.e., book a date for the laboratory test, undergo the test, collect report, and visit the doctor on different days at different locations. For a BPL patient, travelling back and forth from residence to this hospital for preoperative workup, these indirect costs (transportation and loss of wages) are substantial. Hence, these patients prefer to get admitted without complete preoperative work-up and have a prolonged waiting time before elective surgery.

Although there is universal health coverage policy[10] declared by the Government of West Bengal, it covers only basic services, medicines, and consumables. Special investigations (e.g., computerized tomography Scan, magnetic resonance imaging, ultrasound sonography, stress echocardiography (ECG), stress ECG, special pathology, microbiology, and biochemistry tests) are chargeable by the hospital or done from private laboratories. Special surgical consumables and special medicine need to be purchased by the patient's family before surgery and handed over to the OT staff. The medical store or pharmacy of the hospital does not ordinarily supply these items. If the medical store or pharmacy supply these items on special permission from hospital authority, it usually takes a long time, since it is not a regular purchase process.

A management study[11] in a large teaching hospital in Kolkata revealed an average waiting time of 10.4 days per operation and an average LOS of 14.3 days.

The consultant surgeons and anesthetists are on fixed monthly payroll (not on a fee-for-service scheme); they are not available beyond the stipulated OT hours. Hence, extending the existing working hours of the OT to increase OT output will not be possible, as trainee surgeons and anesthetists cannot work without the supervision of qualified surgeons and anesthetists. Although commissioning additional OTs will involve large capital expenditure, it is inevitable to do so to increase the availability of day OT slots. We have shown by applying the Erlang–A model[6] of the queueing theory, that there is abnormally high traffic intensity of the existing 5 OT rooms (servers). Servers cannot be made any faster significantly, as each surgery will take its own time to be completed safely. Hence, the only option is to increase the number of servers, i.e., increasing the number of OTs (with proportionate qualified workforce). This will reduce the traffic intensity and congestion of the system and will reduce the inpatient waiting time.

The hospital has a sixteen bedded ICU where surgical patients compete with medical patients for availing ICU care. On few occasions, complex major surgery was delayed due to nonavailability of ICU bed on the day of surgery.

Availability of blood products is usually a less important factor for delay in surgery unless the patient needs preoperative blood transfusion to correct severe symptomatic anemia before urgent surgery, or has a rare blood group, or needs a large quantity cross-matched before a complex-major surgery, or the lack of availability of replacement blood donor from patient's family or friends.

This study has revealed that sicker patients (higher ASA physical status) waited more than less sick patients (lower ASA physical status), [Table 2]. This is contrary to the usual expectation of patients. This might be due to the fact that sicker patients required more detailed preoperative laboratory tests, more frequent blood transfusions, more frequent cross-specialty consultations than less sick patients.

Larger studies spanning over one calendar year are required to measure the average waiting time for all surgical specialties of the particular institute. Such studies can detect temporal variations in waiting time and the effect of corrective measures.

Conclusion

This study explores one of the major problems of tertiary surgical care in a state government teaching hospital of India– patients waiting for surgery after hospitalization. This study identified root causes of such delays in the inpatient waiting time and recommended pragmatic solutions to the problem.

The modifiable factors (in highest to the lowest order of influence) affecting the inpatient waiting time are depicted in Figure 2. These factors can be modified in a favorable way through control measures which include:

1. Completing the PAC and preoperative workup (whenever feasible) before hospital admission
2. Shortening the admission to PAC interval by speedy laboratory work-up. Availability of a single location integrated laboratory and imaging services within the hospital itself will speed up preoperative work-up
3. Shortening the PAC to surgery interval by increasing the number of available OT slots by increasing the number of OTs ("servers") with commensurate resources
4. Making the process of cross-specialty consultation faster. Involvement of anesthesiologists as perioperative physicians, rather than multiple consultation with multiple medical specialists will speed up the process of cross-specialty consultation
5. Making the process of blood product booking and procurement faster through digital networking of all Blood Banks in the State, and real-time data sharing among those Blood Banks. Motivating the family members and friends of surgical inpatients to make voluntary blood donations at the hospital blood bank will also facilitate faster blood product availability
6. Procurement and supply of all the basic and special medicine, consumable and implants by the Hospital Store and Pharmacy, instead of the existing system of purchase and handover by patient's family
7. Increasing the availability of earmarked Surgical ICU beds.

The results of this study will be useful to policymakers in government health-care organizations in the developing countries to improve the quality of tertiary surgical care services by reducing the inpatient waiting time and promoting equitable access to tertiary surgical care.

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Conflicts of interest

There are no conflicts of interest.

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